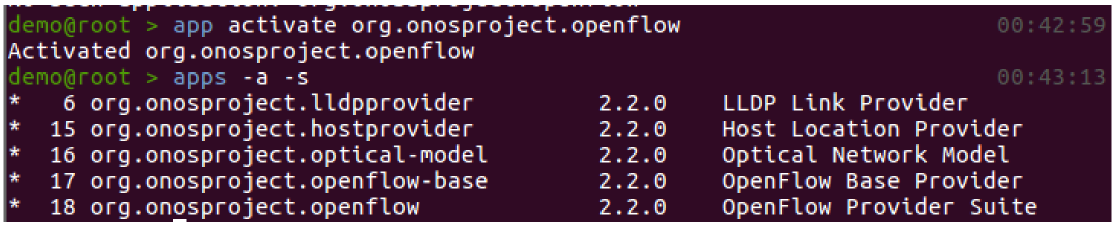
軟體定義網路及網路功能虛擬化 109550206 陳品劭 Lab1

Part1.

1. When ONOS activates **"org.onosproject.openflow,"** what are the APPs which it also activates?



```
demo@root > app activate org.onosproject.openflow                    00:42:59
Activated org.onosproject.openflow
demo@root > apps -a -s                                               00:43:13
*   6 org.onosproject.lldpprovider          2.2.0    LLDP Link Provider
*  15 org.onosproject.hostprovider          2.2.0    Host Location Provider
*  16 org.onosproject.optical-model         2.2.0    Optical Network Model
*  17 org.onosproject.openflow-base         2.2.0    OpenFlow Base Provider
*  18 org.onosproject.openflow              2.2.0    OpenFlow Provider Suite
```

Answer:

(1) "org.onosproject.lldpprovider"

(2) "org.onosproject.hostprovider"

(3) "org.onosproject.optical-model"

(4) "org.onosproject.openflow-base"

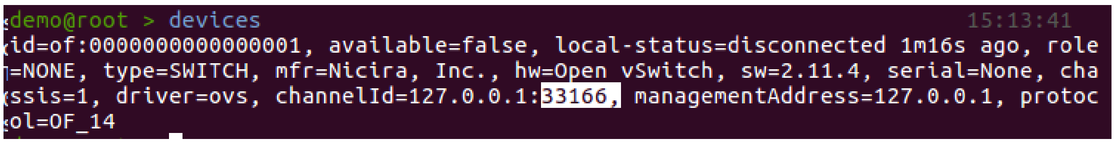
2. As topology in p.22, can H1 ping H2 successfully? Why or why not?

   Answer: NO.

   Since there are no flows installed on the data-plane, which forward the traffic appropriately. We need to activate a simple Reactive Forwarding app that installs forwarding flows on demand, "org.onosproject.fwd", which is not activated by default.

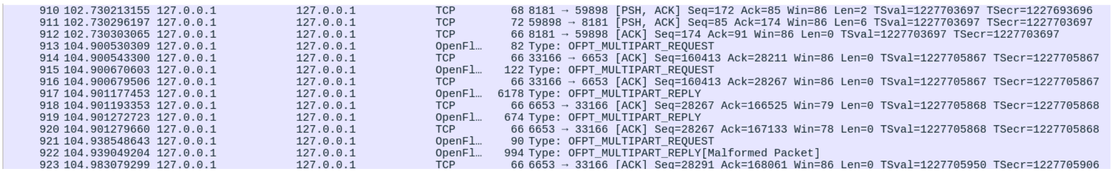
3. Which TCP port the controller listens for the OpenFlow connection request from the switch?

   Answer: 6653



```
demo@root > devices                                                  15:13:41
id=of:0000000000000001, available=false, local-status=disconnected 1m16s ago, role
=NONE, type=SWITCH, mfr=Nicira, Inc., hw=Open vSwitch, sw=2.11.4, serial=None, cha
ssis=1, driver=ovs, channelId=127.0.0.1:33166, managementAddress=127.0.0.1, protoc
ol=OF_14
```

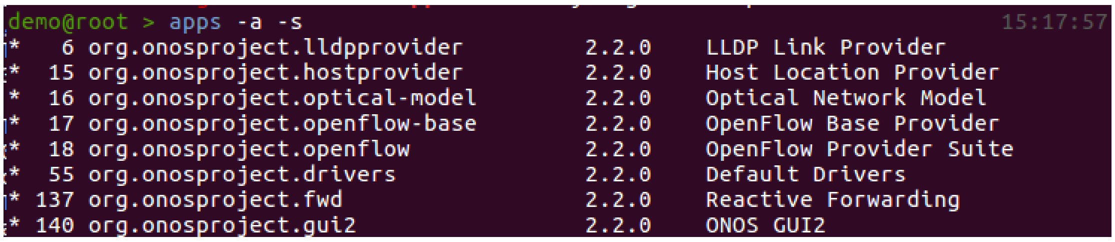
透過 devices 我們可以知道 switch 的 port 是 33166，然後 c0 ping s1，觀察 wireshark，可以發現與 switch 的 port 33166 交流的 port 是 6653，因此 ONOS 的 TCP port 即為 6653。



```
910 102.730213155 127.0.0.1       127.0.0.1       TCP         68 8181 → 59898 [PSH, ACK] Seq=172 Ack=85 Win=86 Len=2 TSval=1227703697 TSecr=1227693696
911 102.730296197 127.0.0.1       127.0.0.1       TCP         72 59898 → 8181 [PSH, ACK] Seq=85 Ack=174 Win=86 Len=6 TSval=1227703697 TSecr=1227703697
912 102.730303065 127.0.0.1       127.0.0.1       TCP         66 8181 → 59898 [ACK] Seq=174 Ack=91 Win=86 Len=0 TSval=1227703697 TSecr=1227703697
913 104.900530309 127.0.0.1       127.0.0.1       OpenFl…     82 Type: OFPT_MULTIPART_REQUEST
914 104.900543300 127.0.0.1       127.0.0.1       TCP         66 33166 → 6653 [ACK] Seq=160413 Ack=28211 Win=86 Len=0 TSval=1227705867 TSecr=1227705867
915 104.900670603 127.0.0.1       127.0.0.1       OpenFl…    122 Type: OFPT_MULTIPART_REQUEST
916 104.900679506 127.0.0.1       127.0.0.1       TCP         66 33166 → 6653 [ACK] Seq=160413 Ack=28267 Win=86 Len=0 TSval=1227705867 TSecr=1227705867
917 104.901177453 127.0.0.1       127.0.0.1       OpenFl…   6178 Type: OFPT_MULTIPART_REPLY
918 104.901193353 127.0.0.1       127.0.0.1       TCP         66 6653 → 33166 [ACK] Seq=28267 Ack=166525 Win=79 Len=0 TSval=1227705868 TSecr=1227705868
919 104.901272723 127.0.0.1       127.0.0.1       OpenFl…    674 Type: OFPT_MULTIPART_REPLY
920 104.901279660 127.0.0.1       127.0.0.1       TCP         66 6653 → 33166 [ACK] Seq=28267 Ack=167133 Win=78 Len=0 TSval=1227705868 TSecr=1227705868
921 104.938548643 127.0.0.1       127.0.0.1       OpenFl…     90 Type: OFPT_MULTIPART_REQUEST
922 104.939049204 127.0.0.1       127.0.0.1       OpenFl…    994 Type: OFPT_MULTIPART_REPLY[Malformed Packet]
923 104.983079299 127.0.0.1       127.0.0.1       TCP         66 6653 → 33166 [ACK] Seq=28291 Ack=168061 Win=86 Len=0 TSval=1227705950 TSecr=1227705906
```

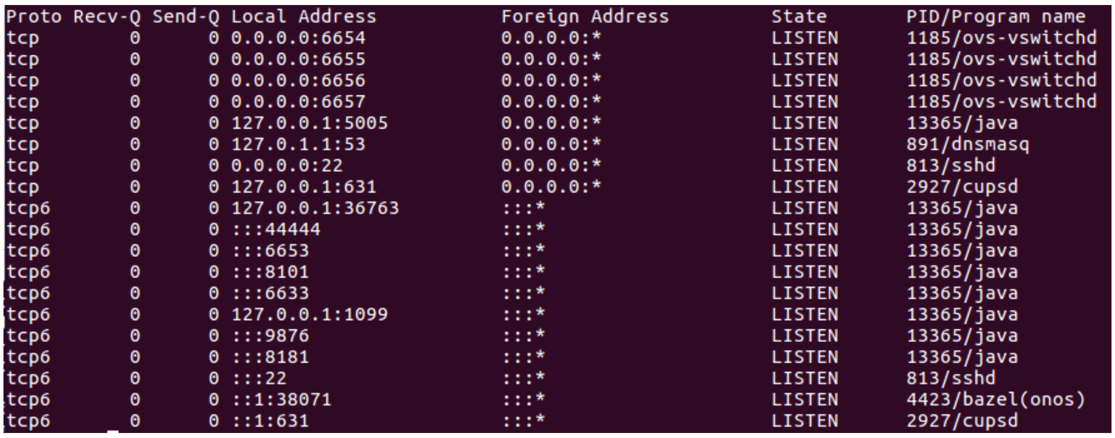
4. In question 3, which APP enables the controller to listen on the TCP port?

   Answer: "org.onosproject.openflow-base".



```
demo@root > apps -a -s                                                   15:17:57
*   6 org.onosproject.lldpprovider          2.2.0    LLDP Link Provider
*  15 org.onosproject.hostprovider          2.2.0    Host Location Provider
*  16 org.onosproject.optical-model         2.2.0    Optical Network Model
*  17 org.onosproject.openflow-base         2.2.0    OpenFlow Base Provider
*  18 org.onosproject.openflow              2.2.0    OpenFlow Provider Suite
*  55 org.onosproject.drivers               2.2.0    Default Drivers
* 137 org.onosproject.fwd                   2.2.0    Reactive Forwarding
* 140 org.onosproject.gui2                  2.2.0    ONOS GUI2
```

當"org.onosproject.openflow-base" deactivate 時，也會有其他的 app 被 deactivate，將它們 activate 回來後(org.onosproject.openflow 不能 activate，因為 org.onosproject.openflow-base 也會 activate)，會發現 port 6653、6633 被關掉了。



```
Proto Recv-Q Send-Q Local Address           Foreign Address         State       PID/Program name
tcp        0      0 0.0.0.0:6654            0.0.0.0:*               LISTEN      1185/ovs-vswitchd
tcp        0      0 0.0.0.0:6655            0.0.0.0:*               LISTEN      1185/ovs-vswitchd
tcp        0      0 0.0.0.0:6656            0.0.0.0:*               LISTEN      1185/ovs-vswitchd
tcp        0      0 0.0.0.0:6657            0.0.0.0:*               LISTEN      1185/ovs-vswitchd
tcp        0      0 127.0.0.1:5005          0.0.0.0:*               LISTEN      13365/java
tcp        0      0 127.0.1.1:53            0.0.0.0:*               LISTEN      891/dnsmasq
tcp        0      0 0.0.0.0:22              0.0.0.0:*               LISTEN      813/sshd
tcp        0      0 127.0.0.1:631           0.0.0.0:*               LISTEN      2927/cupsd
tcp6       0      0 127.0.0.1:36763         :::*                    LISTEN      13365/java
tcp6       0      0 :::44444                :::*                    LISTEN      13365/java
tcp6       0      0 :::6653                 :::*                    LISTEN      13365/java
tcp6       0      0 :::8101                 :::*                    LISTEN      13365/java
tcp6       0      0 :::6633                 :::*                    LISTEN      13365/java
tcp6       0      0 127.0.0.1:1099          :::*                    LISTEN      13365/java
tcp6       0      0 :::9876                 :::*                    LISTEN      13365/java
tcp6       0      0 :::8181                 :::*                    LISTEN      13365/java
tcp6       0      0 :::22                   :::*                    LISTEN      813/sshd
tcp6       0      0 ::1:38071               :::*                    LISTEN      4423/bazel(onos)
tcp6       0      0 ::1:631                 :::*                    LISTEN      2927/cupsd
```

然後再將 org.onosproject.openflow-base activate 後(org.onosproject.openflow 還沒 activate)，會發現 port 6653、6633 被開啟，因此可以確定是 org.onosproject.openflow-base 去開啟的。

Part2.

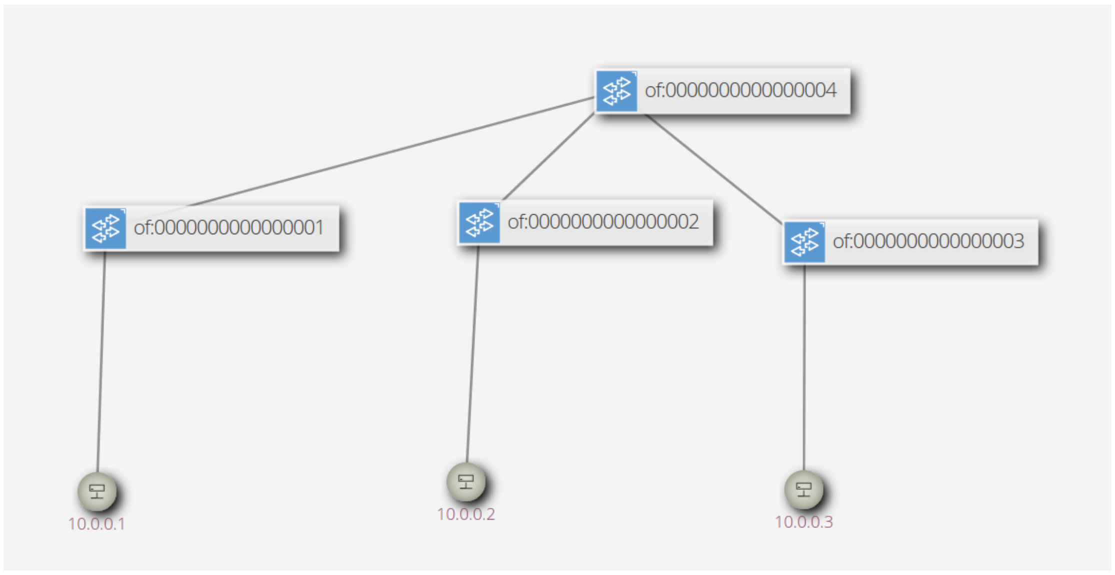
Q: Write a Python script to build the following topology:

Answer:

```python
from mininet.topo import Topo

class Project1_Topo_109550206( Topo ):
    def __init__( self ):
        Topo.__init__( self )

        # Add hosts
        h1 = self.addHost( 'h1' )
        h2 = self.addHost( 'h2' )
        h3 = self.addHost( 'h3' )

        # Add switches
        s1 = self.addSwitch( 's1' )
        s2 = self.addSwitch( 's2' )
        s3 = self.addSwitch( 's3' )
        s4 = self.addSwitch( 's4' )

        # Add links host/switch
        self.addLink( h1, s1 )
        self.addLink( h2, s2 )
        self.addLink( h3, s3 )

        # Add links switch/switch
        self.addLink( s1, s4 )
        self.addLink( s2, s4 )
        self.addLink( s3, s4 )

topos = { 'topo_part2_109550206': Project1_Topo_109550206 }
```

根據圖，建立 4 個 switch(sX = self.addSwitch('sX'))、3 個 host (hX = self.addHost('hX'))，並根據圖上連接方式連結(self.addLink(X, Y))。如上之程式碼。

執行後的 GUI 呈現樣子:



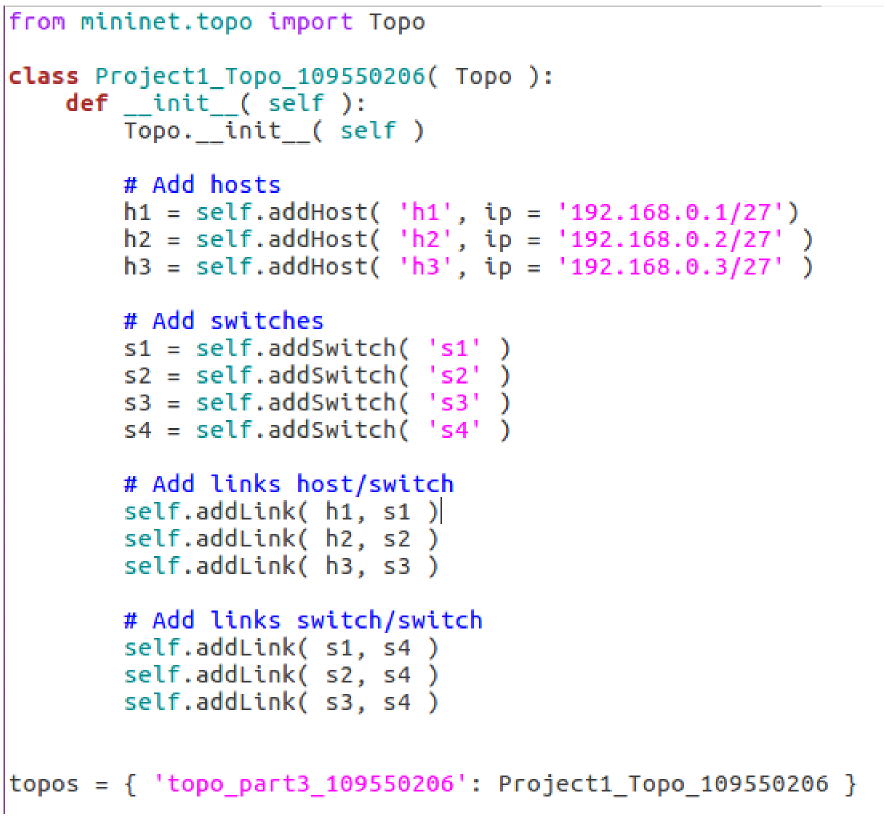
Part3.

Format for manual assignment of host IP address:

■192.168.0.< host_number>

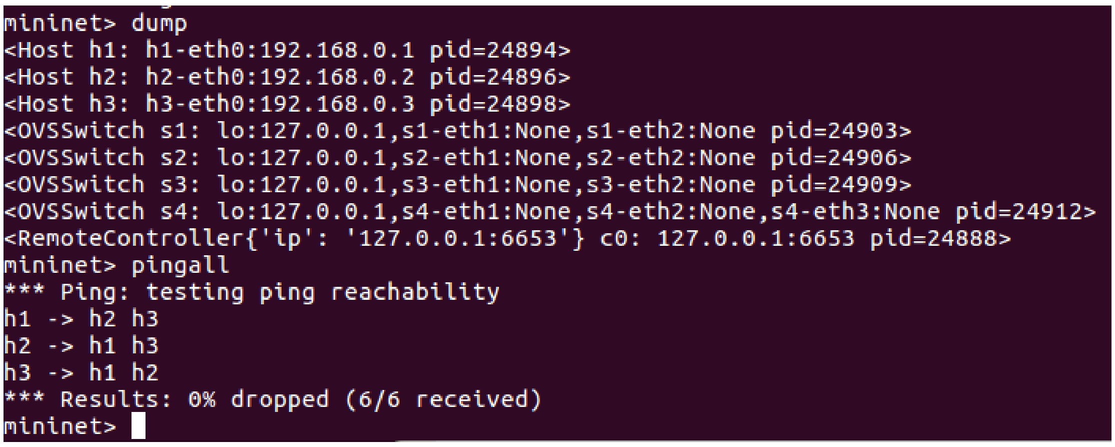
■netmask 255.255.255.224

在 part2 的三個 host 上指定 ip、mask，即於創建 host 時給予 ip 參數，256-224 = 32 = 2^5; 32 – 5 = 27，於 ip 後加上/27 即可指定 mask 為 255.255.255.224。如: hX = self.addHost(‘hX, ip = 192.168.0.X/27‘)。



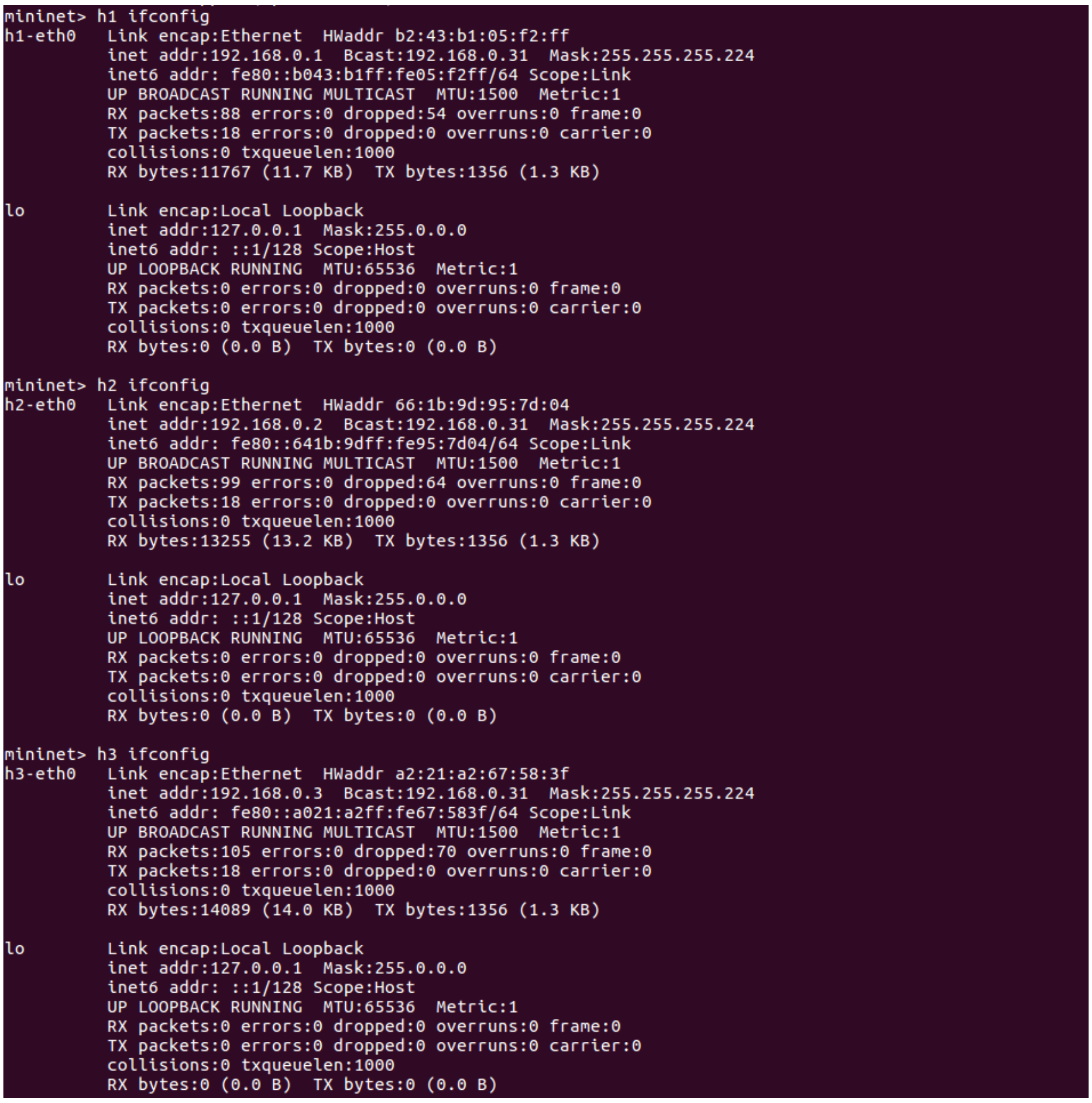
```
from mininet.topo import Topo

class Project1_Topo_109550206( Topo ):
    def __init__( self ):
        Topo.__init__( self )

        # Add hosts
        h1 = self.addHost( 'h1', ip = '192.168.0.1/27')
        h2 = self.addHost( 'h2', ip = '192.168.0.2/27' )
        h3 = self.addHost( 'h3', ip = '192.168.0.3/27' )

        # Add switches
        s1 = self.addSwitch( 's1' )
        s2 = self.addSwitch( 's2' )
        s3 = self.addSwitch( 's3' )
        s4 = self.addSwitch( 's4' )

        # Add links host/switch
        self.addLink( h1, s1 )
        self.addLink( h2, s2 )
        self.addLink( h3, s3 )

        # Add links switch/switch
        self.addLink( s1, s4 )
        self.addLink( s2, s4 )
        self.addLink( s3, s4 )


topos = { 'topo_part3_109550206': Project1_Topo_109550206 }
```

dump、pingall 結果:



```
mininet> dump
<Host h1: h1-eth0:192.168.0.1 pid=24894>
<Host h2: h2-eth0:192.168.0.2 pid=24896>
<Host h3: h3-eth0:192.168.0.3 pid=24898>
<OVSSwitch s1: lo:127.0.0.1,s1-eth1:None,s1-eth2:None pid=24903>
<OVSSwitch s2: lo:127.0.0.1,s2-eth1:None,s2-eth2:None pid=24906>
<OVSSwitch s3: lo:127.0.0.1,s3-eth1:None,s3-eth2:None pid=24909>
<OVSSwitch s4: lo:127.0.0.1,s4-eth1:None,s4-eth2:None,s4-eth3:None pid=24912>
<RemoteController{'ip': '127.0.0.1:6653'} c0: 127.0.0.1:6653 pid=24888>
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3
h2 -> h1 h3
h3 -> h1 h2
*** Results: 0% dropped (6/6 received)
mininet> 
```

h1、h2、h3 ifconfig 結果:


```
mininet> h1 ifconfig
h1-eth0   Link encap:Ethernet  HWaddr b2:43:b1:05:f2:ff
          inet addr:192.168.0.1  Bcast:192.168.0.31  Mask:255.255.255.224
          inet6 addr: fe80::b043:b1ff:fe05:f2ff/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:88 errors:0 dropped:54 overruns:0 frame:0
          TX packets:18 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:11767 (11.7 KB)  TX bytes:1356 (1.3 KB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

mininet> h2 ifconfig
h2-eth0   Link encap:Ethernet  HWaddr 66:1b:9d:95:7d:04
          inet addr:192.168.0.2  Bcast:192.168.0.31  Mask:255.255.255.224
          inet6 addr: fe80::641b:9dff:fe95:7d04/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:99 errors:0 dropped:64 overruns:0 frame:0
          TX packets:18 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:13255 (13.2 KB)  TX bytes:1356 (1.3 KB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

mininet> h3 ifconfig
h3-eth0   Link encap:Ethernet  HWaddr a2:21:a2:67:58:3f
          inet addr:192.168.0.3  Bcast:192.168.0.31  Mask:255.255.255.224
          inet6 addr: fe80::a021:a2ff:fe67:583f/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:105 errors:0 dropped:70 overruns:0 frame:0
          TX packets:18 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:14089 (14.0 KB)  TX bytes:1356 (1.3 KB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

Part4. What you’ve learned or solved

學了 mininet、ONOS 的基本操作，實作網路的一些簡單架構。一開始開 ONOS 不知為什麼會卡在一個地方，會來重裝幾次 VM 後才成功，至於理由仍不明白，接著就是看基礎操作相關說明慢慢熟悉、實作，其中遇到的問題有，一時忘記可以用 wireshark 來得知 port number，以及不知道怎麼設定子網路遮罩的問題，後來查一下才想起來。